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THE ECONOMIC RETURNS TO SCHOOLING IN ISRAEL[1]

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Abstract

This paper examines the causal effect of education on earnings in Israel. The Ordinary Least Squares coefficient of schooling on earnings (the Mincer coefficient) is likely to be biased upwards because it ignores the unobserved 'ability' which is correlated with schooling and has a positive effect on earnings. We use two methods to estimate the causal effect of education on earnings: The first is to use proxy variables—variables that are correlated with the unobserved ability of the individual, such as mother's education and siblings' wage. The second method is to use the amendment to the Compulsory Education Law, which extended free education to all high-school grades, and also raised the minimal age limit for compulsory education by one year, as an instrumental variable. We found that this amendment increased the years of schooling of students whose fathers were born in Asia or Africa. We conclude that the causal effect estimated by the instrumental variable was not different from that obtained using Ordinary Least Squares regressions.

1. INTRODUCTION

This study estimates the economic return to schooling in Israel by attempting to quantify the contribution of additional schooling to earnings. However, in order to analyze the causal relation between schooling and earnings, it is not sufficient to simply compare the salaries of workers with different levels of education. Put another way, raising the level of education among less-educated workers to equal that of better-educated workers will indeed increase the earnings of the former but it is doubtful that the wage gap between the two groups will disappear. This is due to the fact that the schooling decision of better-educated workers is influenced by, among other things, their expectation of achieving a high return to schooling. On the other hand, individuals who choose not to study do so because they expect a low return to schooling. In other words, the relation between schooling and earnings is subject to the classic problem of endogeneity since both schooling and earnings are influenced by other factors such as ability (as measured by IQ tests). Furthermore, both

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schooling and earnings are affected by unobservable variables, such as personal preferences. Thus, highly motivated individuals who have a low preference for leisure will acquire more schooling and will invest greater effort in work. Therefore, the high earnings of the better-educated will reflect not only more years of schooling but also differences in intelligence, perseverance, effort on the job and other characteristics.

The return to schooling estimated in conventional (Mincer-type) wage regressions reflects not only the return to a year of schooling but also the return to characteristics that are correlated with education, such as ability and motivation. The econometric problem is one of omitted relevant explanatory variables (which determine earnings) that are correlated with the level of education and lead to an upward bias in the estimate of the return to schooling. This result has particular relevance for government policy in education and its contribution to reducing economic inequality and increasing productivity. If the omission of variables for ability and environment has no significant effect on the estimate of the return to schooling, then increasing the education of less-educated groups or individuals will lead to an increase in output and a reduction in income inequality. In contrast, if the estimate for the return to schooling is biased upward, then efforts by the government to increase the schooling of less-educated groups and individuals will not have the intended effect since a low level of education is simply an indicator of the problem rather than the problem itself.

The importance of correctly estimating the causal relation between education and earnings became even greater with the large increase in the return to schooling in Israel during the 1980s and early 1990s (as found in estimating the Mincer equation). These findings are evidence of an increase in the profitability of investment in education, which can be exploited by the government in order to improve the productivity and standard of living of less-educated segments of the population. However, it is also possible that the increase in the return to schooling reflects an increase in the return to other characteristics that are correlated with education (such as ability, motivation, perseverance, etc.). Indirect evidence of this is the increase in inequality within groups with the same level of education in Israel (Dahan, 2001; Yutav-Solberg, 2002), which tends to indicate an increase in the return to ability.

Numerous studies, primarily in the US, have attempted to test whether the return to schooling estimated in conventional OLS (Mincer) regressions is biased upwards or, in other words, whether the higher earnings of better-educated workers is a result of their higher level of education or whether it partly reflects the return to other characteristics that are correlated with education. The most important characteristic that researchers have sought to control for is innate intelligence, which they measure using the results of IQ tests. Griliches (1977) examined the return to schooling using a sample of 3,025 30-year-olds. He found that the addition of IQ scores (from tests done in high school) as an explanatory variable did in fact reduce the coefficient of education in the regression from 6.8 percent to 5.9 percent. Griliches, however, suspected that IQ scores are correlated with environmental variables (and therefore do not measure innate ability alone) and that there are unobservable variables, such as motivation, which simultaneously affect both the level of education and earnings. Therefore, he made use of a sample of siblings, since there is a high degree of correlation in unobservable environmental variables between siblings brought up in the

same environment and by the same parents. Griliches also included both IQ scores and background variables (mother's education, father's occupation, number of siblings, etc.) as explanatory variables. He found that the return to schooling among siblings is lower by 0.9 percent than that found for a regular sample using IQ scores and additional background variables. Similar results were obtained using TSLS estimation (though not using a sample of siblings), which assumed that environmental conditions, such as mother's education, father's occupation and cultural environment, also affect the scores on high-school IQ tests. Griliches claimed that in contrast to the upward bias resulting from the correlation between education and ability, there is a downward bias resulting from errors in the measurement of education. In the US, it was found that 10–15 percent of individuals inaccurately reported their level of education. Measurements errors of that magnitude reduce the estimate of the return to schooling in a conventional regression by 10–15 percent.

Later studies focused on the supply of education. In this way, the researchers were able to avoid the Gordian knot connecting education, innate ability, acquired ability, motivation and other unobservable variables. These studies attempted to identify the impact of education through major changes in policy that are unrelated to ability, motivation, etc. Harmon and Walker (1995) estimated the effect of the institution of a compulsory education law in the UK which led to a significant increase in years of schooling. The changes in the law served as instrumental variables for years of schooling and it was found that the return to schooling estimated in such a regression (15–16 percent) was significantly higher than that estimated from a conventional equation (6 percent). Limoux and Card (1998) estimated the impact of opening up Canadian universities to young demobilized soldiers who had volunteered for military service during World War II. The proportion of volunteers was very high among English speakers and very low among French speakers, which enabled the researchers to use the interaction between mother tongue and year of birth as an instrumental variable for years of schooling. In this way, the return to additional years of schooling was estimated for English speakers who were of military age during the war years relative to comparable French speakers (and English speakers who were too young or too old to volunteer). It was found that the return to schooling estimated using the instrumental variable (16.4 percent using a survey from 1971 and 7 percent using a survey from 1981) was higher than that estimated from a conventional regression (7 and 6.2 percent, respectively).

Angrist and Krueger (1991) came up with an original way to estimate the return to schooling using the fact that in the US individuals born at the beginning of the year had fewer years of schooling than did individuals born at the end of the year. They attributed this to the impact of the law for compulsory education, which defined compulsory education according to age rather than years of schooling. Thus, children born at the end of the year acquired an additional year of schooling in comparison to those born at the beginning of the year. Angrist and Krueger assumed that the quarter during which a child is born is random and used it as an instrumental variable for education. They found that the return to schooling is larger than that obtained in a conventional regression.

This study estimates the return to schooling for an individual rather than for the economy as a whole. The return for the economy is identical to that of an individual in perfect competition but is liable to be higher if there are externalities to education or lower

if investment in education serves as a signal of ability. In addition, the study does not examine the elasticity of the return to schooling relative to the proportion of educated individuals. This, in spite of the fact that an increase in the supply of educated individuals is likely to reduce the return to schooling in the economy. The main constraint in estimating the return to schooling in Israel relative to other countries is due to a lack of accessible data on individual IQ scores. The use of such data in the future when it becomes more available will improve our understanding of the issue.

The study is constructed as follows: Section 2 presents the data and the research strategy. Section 3 estimates the return to schooling while controlling for the individual's environment (such as mother's education, father's income and number of siblings). The return to schooling is also estimated for siblings. In Sections 4 and 5 we estimate the return to schooling using an instrumental variable. In Section 4 we use the fact that in 1979 the graduated payment for high school education was cancelled (and, in addition, the Compulsory Education Law was extended by an additional school year), which increased the years of schooling for low-income ethnic groups (Arabs and Oriental Jews). In Section 5 we use a variable for the season of birth as an instrumental variable, as in Angrist and Krueger (1991). Section 7 concludes.

2. DATA AND RESEARCH STRATEGY

Our database included, among other things, the 1995 Census of Population and Housing. The probability of answering the whole questionnaire was 20 percent which provides a representative sample of the population in Israel. The Census contains detailed information including salaries in September 1995, number of days and hours worked during that month, years of schooling, the highest diploma achieved, year of birth, religious affiliation, the individual's country of birth and that of his parents, and marital status. The census data was combined with the Population Registry, thus making it possible to locate relatives of first degree who were sampled in the Census (and to trace siblings who were living in different households and to identify parents living in a different household from their children). In addition, the database included annual salary files of the National Insurance Institute for 1983–95. The Income Survey and Labour Force Survey for the period 1996–2005 were also used in the study.

In principle, the return to a year of schooling (education) can be estimated from the following equation:

$$(1) \qquad y_i = \alpha + \beta_1 s_i + \beta_2 X_i + \beta_3 A_i + \mu_i \ ,$$

where y is the log of earnings, s is years of schooling, X is a vector of known variables (such as age, gender, etc.) and A is an ability variable (or a vector of unobservable variables that include, in addition to ability, motivation, values, etc.). The problem arises because we do not have information on the ability variable (which is therefore an omitted variable) and because this variable is correlated with education. If we assume the following:

(2) $s_i = \delta_1 A_i + \delta_2 X_i + v_i$,

then the estimation of Equation 1 without an ability variable will produce a biased estimate of the return to schooling:

(3) $E\hat{b}_{ys} = \beta_1 + \beta_3 \operatorname{cov}(A_i, s_i) / \operatorname{var}(s_i)$.

The literature suggests two ways of dealing with this problem: The first is to include observable variables in the regression that are correlated with the omitted variable (i.e., proxies for the unobservable variable). For example, one could use variables related to the individual's environment to replace ability and motivation variables (as is done in Section 2). The second way of dealing with the problem is to identify an instrumental variable *Z* that influences education but is not correlated with earnings (Sections 3 and 4). An example of such a variable is the institution of a compulsory education law or a reduction in tuition. We will estimate the education and the earnings equations, and the instrumental variable will replace the years of schooling variable in the earnings equation:

(4) $s_i = \pi_1 Z_i + \delta_1 A_i + \delta_2 X_i + \eta_i$,

(5) $y_i = \alpha + \pi_2 Z_i + \beta_2 X_i + \beta_3 A_i + \varepsilon_i$.

The estimator of the return to schooling will be calculated as: $\hat{\beta}_1 = \pi_2 / \pi_1$ and is consistent if the return to schooling is identical for all individuals. (Note that A_i is part of the error term in both the first stage and reduced form equations.)

3. THE RETURN TO SCHOOLING AND FAMILY BACKGROUND

We first estimate the return to schooling using a standard OLS regression. The dependent variable is the log of earnings in September 1995, while the explanatory variables are years of schooling, age, age squared, gender, hours of work, dummy variables for marital status (married, single, divorced or widowed) and ethic origin (non-Jewish and three groups of Jews according to father's country of origin: Asia/Africa, Europe/America and second-generation Israeli), which are also used in the regressions below. The estimation relates to individuals who were surveyed in the 1995 Population and Housing Census and since the study focuses on the estimation of the return to schooling acquired in the local school system, we restricted the sample to individuals born in Israel and aged 26–45 in 1995. Individuals working only part-time in 1995 were removed from the sample, as were those who reported more than 23 years of education. Years of schooling do not include those spent at a higher yeshiva (Talmudical college).[2] In total, the sample included 66,000

[2] Individuals whose last school attended was a yeshiva were included in the sample though the years spent there were not included in the total years of schooling.

individuals. The return to schooling according to this specification was 7.2 percent (see Regression 1 in Table 1).

In order to control for the individual's other socioeconomic characteristics, the individuals sampled in the 1995 Census (which was used for Regression 1 and which included about 66,000 individuals) were paired with their parents who were surveyed in the same census. The intergenerational sample, which included about 12,000 observations, made it possible to control for the characteristics of an individual's parents, including mother's education, father's income and number of siblings. In Regression 2 (and Table A1 in the Appendix) we estimated the return to schooling in the sample using only the individual's characteristics that were used in Regression 1. (The dependent variable is the log of monthly earnings, while the explanatory variables are years of schooling, age, age squared, gender, ethnic origin, hours worked and marital status.) The estimate of the return to a year of schooling in this regression is 7.0 percent, which is lower than that obtained in the representative sample (7.2 percent in Regression 1). Regression 3 also relates to the intergenerational sample, though it includes additional explanatory variables relating to the individual's parents (in addition to the explanatory variables in Regression 2): mother's education, father's income in 1988, father's age and number of children in the family. The inclusion of these four additional variables reduces the return to schooling by 0.8 percent, to 6.2 percent.[3] The results of Regression 3 indicate that a decrease in the number of siblings or an increase in the mother's education or the father's income leads to an increase in the son's income beyond that resulting from the indirect effect that operates through education and from it to earnings. Ignoring the direct effect of family background on the children's earning biases the return to schooling while the inclusion of dummy variables for family background enables us to estimate the return to schooling among a homogenous group and therefore to reduce the bias.

An alternative way to control for the socioeconomic environment in which the individual has grown up is by including the characteristics of siblings. Regression 4 and 5 relate to a sub-sample of some 4,000 pairs of siblings who were both surveyed in the 1995 Census. Regression 4 estimates the return to schooling using the same explanatory variables as Regression 1 (years of schooling, age, age squared, gender, ethnic original, hours of work and marital status). The estimated return to schooling obtained from this regression is 7.5 percent. In the siblings sample, there is over-representation of large families, who often suffer from liquidity restraints, and therefore the return to schooling obtained in this sample is higher than that obtained from the representative sample (7.2 percent—Regression 2 in Table 1). Regression 5 includes a number of additional explanatory variables that are meant to control for the socioeconomic environment in which the individual grew up: sibling's years of schooling, sibling's income, age and gender, and number of siblings in the family. In addition, the regression includes dummy variables for the sibling's marital status. The inclusion of these variables reduced the estimate of the return to schooling by one

[3] We would mention that a similar reduction in return to schooling was obtained when the father's salary in 1988 was replaced by his salary in 1995 (from data of the National Insurance Institute) although this substitution reduces the number of observations by 25 percent, since many of the fathers had retired during the intervening years.

percentage point to 6.4 percent. The use of sibling variables led to a more significant reduction in the estimate of the return to schooling relative to the intergenerational sample, apparently because among the children of immigrants (and also among minorities) education and the income of siblings constitutes a better proxy for ability than parents' education and income.

Table 1
Estimate of the return to schooling in the intergeneration sample and the sibling sample

	Overall sample	Inter-generational sample		Sample of siblings		Sample of siblings and father's income		Sibling and intergenerational Sample	
	1	2	3	4	5	6	7	8	9
Years of schooling[1]	0.072	0.070	0.062	0.075	0.064	0.071	0.058	0.067	0.050
	0.001	*0.003*	*0.002*	*0.002*	*0.002*	*0.003*	*0.003*	*0.006*	*0.007*
Age, ethnic origin, gender, hours of work and marital status	+	+	+	+	+	+	+	+	+
Age and income of father, mother's education and number of siblings			+						
Earnings, schooling, gender and age of sibling and number of siblings					+		+		+
Father's income in 1988							+		
R^2	0.299	0.273	0.283	0.321	0.340	0.320	0.342	0.321	0.361
Observations	66,349	12,384		10,748		5,692		1,234	

[1] Standard deviations appear in the bottom row. The full results appear in Table A1 in the Appendix.

Regressions 6 and 7 relate to a subsample that includes pairs of siblings who were surveyed in the census and for whom we had data regarding their parents' income in 1988. Regression 6 estimates the return to a year of schooling using the basic variables that were used in Regression 1 (and also in Regressions 2 and 4) and produces an estimate for return to schooling (7.1 percent) which is close to that obtained for the representative sample. Regression 7 includes additional explanatory variables, and controls for sibling characteristics (education, salary, age and gender), the number of siblings and the father's income in 1988 (from National Insurance Institute data). The estimate of the return to schooling in this regression is only 5.8 percent. Thus, the inclusion of the control variables relating to the sibling and the father reduces the estimated return to schooling by 1.3 percentage points. Regression 8 and 9 relate to a sub-sample that includes a cross-section of 1,234 observations from the sibling and intergenerational samples. As a result of the inclusion of the control variables (mother's education, father's education, sibling's income, father's income and the number of siblings), the estimated return to schooling declined by 1.7 percentage points (from 6.7 percent in Regression 8 to 5.0 percent in Regression 9).

Ashenfelter and Krueger sought to completely neutralize the effect of environment using a model which assumes that the two siblings enjoy common family characteristics (in additional to characteristics that are unique to each) and found a way to estimate the return to schooling using a regression of differences in which the difference in earnings between the siblings is estimated as a function of the difference in education between them. The use of a regression of differences restricts the coefficients of the regression through the assumption that the common family traits—which are the result of both environmental and genetic factors—affect the earnings and education of each of the siblings in an identical manner.[4] The return to schooling obtained from a regression of differences of this type (see Table A2 in the Appendix) is only 5.4 percent (as compared to 7.5 percent in the OLS regression).

In conclusion, the inclusion of explanatory variables that are intended to control for the individual's environment and ability reduces the estimated return to schooling by about 1.3 to 2 percentage points relative to the conventional Mincer regression. This is similar to the reduction found by Griliches (1977) in the US. Griliches claimed that this difference is not evidence of bias in the Mincer estimation but rather of measurement error in years of schooling.[5] He based his claim on research that had estimated the magnitude of measurement error in years of schooling in the US. Unfortunately, we have no way of estimating the magnitude of measurement error in years of schooling obtained from surveys in Israel but, on the assumption that it is similar to that found in the US, there exists no significant bias in the estimate of the return to schooling obtained from Mincer regressions.

The estimate of the return to schooling could be improved if we possessed cross-correlated information on individuals' level of education, as well as data on their level of IQ. However, even this type of information would leave the problem of estimating the return to schooling unresolved since there are many different characteristics (apart from IQ) that simultaneously affect the success of the individual in school and in the labor market. These characteristics, some of which are unobservable and some of which are not measurable (such as motivation, perseverance, ability to cooperate with others, ability to express oneself, etc.), led researchers to estimate the return to schooling in a completely different way, through the isolation of exogenous changes in the supply side.

[4] The estimation of a regression of differences is identical to the estimation of specification 5 (Table 1) in which the coefficient of the log of sibling's earnings is equal to 1 and the coefficients of the education of the two siblings are equal. The model is open to criticism since the difference in education between the siblings is apparently evidence of the difference in innate ability and motivation and not of the difference in opportunities to acquire education, since the similar environment in which the siblings grew up significantly reduces the inequality of opportunity in acquiring education (relative to a random pair of individuals with a similar difference in education level).

[5] Griliches (1977) claimed that even small measurement errors in years of schooling are liable to cause significant bias. This bias increases with the addition of more control variables that are correlated with education.

4. THE FREE HIGH SCHOOL EDUCATION LAW—THE SUPPLY SIDE EFFECT

An increase in the supply of education is likely to provide a way to unravel the complex relationship between education and ability since an increase in the proportion of educated individuals will make it possible to test whether those benefiting from more education also benefit from higher earnings. A test of this sort requires that an event be identified which significantly and rapidly increased the level of education (but which had no other influence on individuals or the economy). In addition, it is necessary that those who benefit from increased education remain in the labor market for a sufficient period of time for their earnings to provide a good estimate of their long-run earning ability. In Israel, there was an important event that is likely to have affected the supply of education—the extension of the Compulsory Education Law in 1979 so that free high school education now included Grades 10-12, and compulsory education now included Grade 10. To the extent that this change increased the levels of education among a certain age cohort relative to its predecessor, it is possible to estimate the contribution of the increase in education to the earnings of that cohort. Analyzing the whole cohort makes it possible to estimate the return to schooling of a whole group that benefited from the increase in education (rather than estimating it for individuals with particularly high levels of ability and motivation).

In 1978, the government decided to institute free high school education in Grades 10-12 and the Law came into effect in 1979. Up until that time, the level of high school tuition had been based on parents' income and the size of the family and discounts and exemptions were granted to various segments of the population. Yogav and Ayalon (1985), who estimated the effect of the amendment to the Compulsory Education Law (increasing the number of grades of free schooling) on the Jewish population, drew the following conclusion:

Our findings point with certainty to a specific effect of the Law which is reflected in the improvement in perseverance in high school studies in the academic track and increased equality between students of Asian/African (hereinafter Oriental) and Ashkenazi (Central and Eastern European) origins, particularly among boys, in this regard. These findings contradict some of the forecasts that preceded the enactment of the Law, which predicted that it would not improve equality of opportunity in high school education. These forecasts rested primarily on economic considerations that are related to the existence of graduated high school tuition prior to the enactment of the Law.[6] (ibid., p. 73)

The conclusions by Yogav and Ayalon are supported by Table A3 in the Appendix, which presents the average years of schooling by age and ethnic group according to the 1995 Census. It shows that the average years of schooling among Israeli natives with Oriental parents was highly stable for individuals born during the period 1955–60 (12.1–12.2 years of schooling). It rose by 6 months among those born in 1961–63 (who were of high-school age when the Law went into effect) and again stabilized among the next five

[6] Yogav and Ayalon estimated the effect of the Law on the Jewish sector alone but they point out that in the Arab sector, there was a large drop in the proportion of high school dropouts, from 27 percent in 1978 to 21 percent in 1981.

cohorts (12.6–12.8 years of schooling). A similar conclusion was drawn in a study done by Freidlander et al. (2002) which analyzed rates of eligibility for matriculation certificates.

With regard to those who were tested starting from the period around 1970 until those who were tested around 1980, there was a clear upward trend in eligibility among all ethnic groups. The increase in the proportion of eligible individuals who were of Asian/African origin was more rapid and more pronounced than among individuals of European/American origin. As a result, gaps between the ethnic groups narrowed. With regard to students tested after that, closer to 1985, a change can be observed, with the increase in eligibility beginning to level off, both for students of Asian/African origin and for other groups. (Friedlander et al., 2007, p. 104).

In order to estimate the effect of the Law on the rate of high school completion and years of schooling among the population, we also used the Labour Force Survey for the period 2002–05 and distinguished between the various ethnic groups and also between men and women. Table 2 shows that following the enactment of the Law, there was an increase in the proportion of high school graduates and in the average years of schooling among weaker segments of the population, i.e., Arabs and Oriental Jews. In contrast, the Law did not affect other ethnic groups—native Israelis whose parents were born in Europe, America or Israel—whose rate of high school completion was high even before the Law. The impact of the Law was particularly noticeable among Arab and Oriental women. Thus, the rate of high school graduation among Arab girls doubled (from 19 to 39 percent within only 6 years) while the rate among Oriental girls increased significantly (by 13 percentage points within only 4 years) and approached the graduation rates of non-Oriental Jewish women. As a result of the Law, the rate of high school graduates also grew among Oriental and Arab men (by 7 percentage points) though more moderately than among women.

Table 2
Average years of schooling and proportion of high school graduates among native Israelis, according to father's continent of origin and year of birth

	Arab Israelis		Asia-Africa		Europe-America-Israel	
Year of Birth	Men	Women	Men	Women	Men	Women
1958–59	9.3	6.3	12.0	12.6	14.1	14.4
	(37%)	(16%)	(71%)	(78%)	(85%)	(93%)
1960–61	9.8	6.2	12.1	12.5	14.3	14.2
	(40%)	(19%)	(71%)	(77%)	(86%)	(92%)
1962–63	9.6	7.2	12.6	13.1	14.3	14.0
	(39%)	(29%)	(79%)	(88%)	(89%)	(90%)
1964–65	10.6	8.0	12.3	12.9	14.0	14.1
	(47%)	(28%)	(76%)	(90%)	(86%)	(93%)
1966–67	10.0	8.8	12.4	13.0	14.7	14.5
	(46%)	(39%)	(78%)	(90%)	(88%)	(96%)
1968–69	10.1	8.6	12.7	13.1	14.3	14.7
	(46%)	(40%)	(82%)	(91%)	(90%)	(94%)

Source: Labour Force Surveys 2002–05.

In order to estimate the return to schooling, we investigate the effect of the Law on the sub-sample of workers for whom earnings data exist (Table 3). While over the whole sample there was an appreciable increase in the proportion of high school graduates in weaker segments—Arabs and Oriental Jews, both men and women—in the sub-sample of full-time workers, the increase in the years of schooling was particularly noticeable among Oriental men and women, while among Arab male and female workers no significant increase was found. The lack of growth in years of schooling among Arab men is explained by the fact that the increase among Arab men in general was moderate and passing (among those born in 1964–65). The moderate increase in the level of education among Arab female workers reflects the fact that they constitute a small and highly educated group (since most Arab women do not participate in the labor market). The differential effect of the 1979 amendment to the Law on the various sectors requires that we focus on groups that were particularly influenced by it, i.e., native Israelis whose parents were born in Asia and Africa.

Table 3
Years of schooling and earnings in 1995 of cohorts who did or did not benefit from the Compulsory Education Law, according to father's continent of origin and gender (full-time workers only)

		Arab Israelis		Parents born in Asia/Africa		Parents born in Israel or Europe/America	
		Men	Women	Men	Women	Men	Women
1959–61 cohorts relative to 1964–66 cohorts	Change in Education	-0.1	0.3	0.2	0.4	-0.2	0.0
	Change in earnings	-13%	-14%	-13%	-8%	-23%	-9%
	Observations	1,620	259	3,058	2,762	2,342	2,115
1960–61 cohorts relative to 1964–65 cohorts	Change in Education	0.0	0.0	0.1	0.2	-0.2	0.0
	Change in earnings	-11%	-11%	-10%	-6%	-20%	-6%
	Observations	1,131	184	2,029	1,838	1,553	1,393

Source: Population and Housing Census 1995.

We will use the effect of the Education Law on education as an instrumental variable in estimating the return to schooling using the reduced form method. Regression 1 in Table 4 estimates the effect of the Law on years of schooling using a sample that includes six age cohorts close to the time of the change in the Law (the 1959–61 and 1964–66 cohorts) consisting of individuals who worked a full month in 1995 (1995 Census data). The explanatory variables include dummy variables for various population groups (sons of parents of European/American origin, sons of parents of Asian/African origin, daughters of parents of European/American origin, daughters of parents of Asian/African origin, Arab men, Arab women, sons of native Israelis and daughters of native Israelis), dummy variables for the individual's year of birth (for each year separately) and an interaction of

Table 4
Estimation of the effect of the 1979 Compulsory Education Law on education and earnings: Reduced form Sample of 1959–61 and 1954–66 cohorts

	1	2	3	4	5	6
Source of data	1995 Census			Income Survey 1996-2005		
Explanatory variable	Years of schooling	Log of earnings	Log of earnings	Years of schooling	Log of earnings	Log of earnings
Education Law* Oriental Jews	***0.414 (0.077)	***0.048 (0.015)	0.019 (0.014)	***0.460 (0.119)	**0.039 (0.020)	-0.003 (0.087)
Education Law* Arab men	0.025 (0.106)	--	--	-0.102 (0.170)	--	--
Education Law* Arab women	*0.403 (0.241)	--	--	0.090 (0.279)	--	--
Years of schooling	--	--	+	--	--	+
Dummy variables for ethnic group	+	+	+	+	+	+
Dummy variables for years of schooling	+	+	+	+	+	+
Number of hours worked	--	+	+	--	+	+
Dummy variables for marital status	--	+	+	+	+	+
Dummy variables for the year of the Survey	--	--	-	+	+	+
R^2	0.1833	0.2330	0.3244	0.1556	0.3395	0.4816
Observations	22,315	22,315	22,315	11,101	11,101	11,101

Standard deviations appear in parentheses.
*10 percent level of confidence. **5 percent level of confidence. ***1 percent level of confidence.

population group with a dummy for the period following the enactment of the Law. The increase in education among Oriental Jews was found to be significant (for both men and women) during the period of the Law though there was no such increase among Arab men or women.[7] In Regression 2, we estimated earnings in 1995 using the same explanatory variables as the previous regression except for years of schooling, which is not included. We found that the earnings of Orientals who benefited from the Law (average treatment effect on the treated) increased by 4.8 percent which we attribute to the increase in their level of education by 0.4 years of schooling. This implies that the return to a full year of schooling is approximately 11.6 percent. Regression 3 tests whether the increase in earnings of Oriental Jews is in fact the result of the increase in years of schooling. It can be seen that the extra return for Orientals that were of high-school age when the Law was in effect disappears when years of schooling are added to the regression. Since the Education Law graduates were young in 1995 (aged 29–31), we sought to estimate the return to

[7] In a sample that includes both workers and non-workers, the increase in education among Arab men and women was found to be significant. Education among working Arab women did not increase because the proportion of working women is low and their level of education is much higher than average.

schooling for an older age group. To this end, we used the Income Survey for the years 1996-2005. Here again we compared those born in 1964–66, who could have benefited from the Law, to those born in 1959–61 who could not. The increase in education among Oriental Jews who were of high-school age when the Law was in effect was larger than that found using the 1995 Census while the rise in their earnings was lower than that found in 1995. Therefore, the estimate of the return to schooling derived from the Income Survey was lower than that estimated for 1995 (by about 8.5 percent).

A similar method that is used to estimate the impact of the Law on the return to schooling is TSLS (Two Stage Least Squares) which is preferred over the reduced form method since it facilitates the use of a number of instrumental variables in parallel. In the first stage, years of schooling are regressed on the instrumental variable and other variables which are likely to determine the size of the effect of the instrumental variable on the individual's level of education. In the second stage, we regress log earnings on the estimate of years of schooling calculated from the first regression and additional variables that influence earnings. The formal model is:

$$stage\ \ I: s_i^* = \alpha + \beta_1 LwOm_{\ i} + \beta_2 LwOf_{\ i} + \beta_3 X_i + e_{i,t}$$

$$stage\ II: y_i = \alpha + \beta_1 s_i^* + \delta_1 h_i + \delta_2 ms_i + \theta_1 birth_1 + ...\theta_{1+n} birth_{1+n} + \gamma_1 ethnic_{\ 1} + ...\gamma_{1+m} ethnic_{\ 1+m} + u_i$$

where y_i is the log of wage for individual i, h_i is the hours worked, s_i* is instrumental variable for years of schooling (estimated in stage I), and other variables are: $birth_i$, $ethnic_i$ and ms_i—dummies for the various year of birth, ethnic groups (which interact with sex), and marital status, respectively. The two instrumental variables in stage I, $LwOm_i$ and $LwOf_i$, are the interaction between the period of the Law and Oriental men and the interaction between the period of the Law and Oriental women. (Other control variables in stage I, X_i, include dummies for the various ethnic groups (which interact with sex), year of birth, marital status and hours worked.)

The results of the TSLS estimation of return to schooling appear in Table 5 (and in Tables A4 and A5 in the Appendix). All the regressions included the basic explanatory variables (dummies for the various ethnic groups, year of birth, and marital status and hours worked) and two instrumental variables: the interaction of the period of the Law and Oriental men and the interaction of the period of the Law and Oriental women. The regressions in the first two columns are based on the 1995 Census of Population and Housing. The first column relates to the 1959–61 and 1964–66 cohorts (which were also used in the reduced form estimation), in the first stage regression (column 1) we find a significant increase in the years of schooling for Oriental men and women who were at high-school age at the time the Free Education Law went into effect. The second stage which regressed the log earnings on the estimate of years of schooling calculated from the first regression yields an estimate of 12.4 percent to one year of schooling. Column 2 relates to the first two cohorts that benefited from the Law (those born in 1964–65) and to the last two cohorts who did not (those born in 1960-1961). The reduction in the number of cohorts increased the estimated return to schooling and its standard deviation.

Table 5
Estimates of the return to a year of schooling from the OLS and TSLS regressions and coefficients of the instrumental variables in the first-stage regression

	1	2	3	4
Source	1995 Census		Income Survey 1996–2005	
Year of birth	1959–61 and 1964–66	1960–61 and 1964–65	1959–61 and 1964–66	1957–61 and 1964–68
TSLS Years of schooling	***0.124 (0.036)	**0.142 (0.067)	**0.081 (0.041)	***0.080 (0.032)
	First Stage Regression – Coefficients of the Instrumental Variables			
	1	2	3	4
Oriental men* Law	***0.322 (0.083)	*0.177 (0.102)	***0.564 (0.129)	***0.571 (0.100)
Oriental men* Law	***0.487 (0.087)	***0.330 (0.107)	***0.379 (0.134)	***0.350 (0.103)
R^2	0.195	0.197	0.156	0.164
Observations	22,315	14,822	11,101	18,457

The explanatory variables in all the models: dummy variables for ethnic groups, dummy variables for year of birth, dummy variables for marital status (married, single, divorced or widowed) and number of hours worked. Model 3 and 4 include dummy variables for the year of the Survey.
* 10 percent level of confidence. Standard deviations appear in parentheses. ** 5 percent level of confidence.
*** 1 percent level of confidence.

Columns 3 and 4 estimate the return to schooling achieved by those benefiting from the Law over an extended period using the Income Survey for the years 1996 to 2005.[8] Column 3 is based on the same cohorts as the first model (individuals born in 1959–61 and those born in 1964–66). Here again we find a significant increase in the years of schooling for Oriental men and women who were at high-school age at the time the 1979 Education Law went into effect, although the increase found for Oriental men was higher than that found using the 1995 Census. The estimated return to schooling during the period 1996–2005 was 8.1 percent, which is much lower than the estimate of 12.4 percent obtained for the 1995 data. When four additional cohorts were added to Column 4, the estimated return to schooling was almost unchanged though its variance was reduced.

The return to schooling estimated in Table 4 and 5 remains valid even if the increase in the education for Oriental Jews is not the result of the Education Law but rather is due to a different variable that affected the supply side.[9] One of the factors that may reduce the validity of the estimation is the process of integration of Oriental Jews into Israeli society which was manifested in a simultaneous increase in their education and earnings over

[8] These regressions also include dummy variables for the year of the sample.

[9] The results do not remain valid to the extent that the increase in the level of education among Oriental Jews is the result of demand factors that are not controlled for in the model (such as the increase in parents' level of education) and to the extent that these factors simultaneously increased both the individuals' level of education and their earning ability through, for example, the direct influence of language skills, IQ, motivation, etc. However, the chances of such significant changes over a short period of time are small.

time.[10] In order to rule out such a possibility, we investigated the impact of the Law in an alternative manner, by focusing on the individual's economic background rather than his ethnic background.

Table 6
Estimates of the return to a year of schooling from the TSLS regressions and coefficients of the instrumental variables in the first-stage regression Data from the 1995 Census

	1	2
Year of birth	1959–61 and 1964–66	1960–61 and 1964–65
TSLS Years of schooling	***0.145 (0.040)	**0.162 (0.057)
Auxiliary equation – Coefficients of the instrumental variables		
	1	2
Free Education Law* Earnings of father in 1988	***-0.004 (0.001)	**-0.004 (0.002)
Free Education Law* Number of siblings	***0.060 (0.001)	***0.049 (0.017)
Earnings of father in 1988	***0.012 (0.001)	***0.012 (0.001)
Number of siblings	***-0.228 (0.012)	***-0.220 (0.015)
R^2	0.195	0.197
Observations	13,829	9,131

Standard deviations appear in parentheses.
* 10 percent level of confidence. ** 5 percent level of confidence. *** 1 percent level of confidence.

Since the hypothesis being tested is that the Free Education Law acted primarily to increase the level of education among poor and large families, the interaction between family background and the Law can be used as an instrumental variable in the estimation of education.[11] In order to carry out this estimation, we used 1995 Census data that was combined with the Population Registry and earnings data from the National Insurance Institute. The results of the estimation appear in Table 6 (and Table A3 in the appendix). The model was estimated using TSLS and apart from the basic variables (age, age squared, gender, ethnic origin, marital status and hours worked), the regression included family background variables (number of siblings and father's income in 1988) and two interaction

[10] In order to revive the claim that the increase in the level of education among Oriental Jews during the relevant period is related to the Law, we attempted to determine whether there was an increase in earnings and education in a random year that preceded the Law (by comparing the 1948–54 cohorts to the 1956–62 cohorts). It was found that the education and earnings of younger Oriental men were no different from those of the previous generation.

[11] See Card and Lemieux (2001) who investigated the effect of a reduction in university tuition for Canadian soldiers who served in the Second World War. We would emphasize that family background variables do not themselves constitute instrumental variables and therefore the existing correlation between them and the earnings variable does not create an econometric problem.

variables (father's income in 1988 and number of siblings for individuals who reached high-school age when the Law was in effect). In the first-stage regressions, it was found that an increase in the father's income had a positive effect on the individual's level of education while an increase in the number of siblings had a negative effect (see Table A4 in the Appendix). These two effects weakened during the period in which the Law was in effect. Thus, there was a statistically significant increase in the level of education among individuals who had a large number of siblings and whose father had a low level of income. Using the predicted years of schooling in the second-stage regression, revealed that the return to schooling grew significantly to 14.5 percent in column 1 (which relates to the 1959-61 and 1964-66 cohorts) and to 16.2 percent in column 2 (which relates to the 1960-61 and 1964-65 cohorts).[12] The estimates obtained in these regressions overestimate the return to schooling since they relate to a population that had a higher proportion of liquidity-constrained individuals than that in the general population. The liquidity constraint illustrates the heterogeneity in the return to schooling since the return required by liquidity-constrained individuals is higher than that for the rest of the population and therefore their level of education is lower and their return to schooling is higher. As a result, these results can only be used to estimate the return to schooling for liquidity-constrained individuals rather than for the population as a whole.

The estimate obtained from the instrumental variable for Orientals is not a consistent estimate of the economy's return to schooling since we have estimated the effect of the Free High School Education Law only for Oriental Jews who have a higher return to schooling than the rest of the population. Table 7 compares the return to schooling attained by an individual of Oriental origin who chose to increase his level of education due to his skills, dedication or some other reason (OLS regression) with the return attained by an individual who increased his level of education as a result of the enactment of the Free High School Education Law (instrumental variable method). The results are somewhat ambiguous. Thus, in 1995, a higher return (by about 3 percentage points) was estimated for education obtained as a result of the Law relative to education obtained otherwise. In contrast, the return to schooling obtained as a result of the Law was lower during the period 1996-2005 (by 1.7 percent points). Although the gap in 1995 was larger, more weight should in fact be given to the results obtained using the Income Survey, which represents a longer period. In any case, the estimates obtained using instrumental variables from both sources of data have a high level of variance and are not significantly different statistically from those obtained in a Mincer regression.

[12] We attempted to estimate the hypothesis that the Law did not influence the less affluent population, which had been exempt from tuition already prior to the Law. To this end, we included additional explanatory variables: interaction variables of the Law with earnings squared and of the Law with the number of siblings squared. The coefficients were not found to be significant in the auxiliary regression.

Table 7
Comparison of estimates of return to schooling for Oriental Jews obtained from a Mincer regression and a TSLS regression, according to the 1995 Census and the Income Survey for the years 1996-2005[1]

	Mincer Regression – OLS	Instrumental variables – TSLS
1995 Survey	9.5 percent	12.4 percent
Income Survey for the years 1996-2006	9.7 percent	8.0 percent

[1] Individuals born during the periods 1959-61 and 1964-66.

As mentioned above, the results obtained using instrumental variables are not affected by the correlation between ability and education that leads to an upward bias in OLS estimates, nor are they subject to the effect of measurement errors that lead to a downward bias in OLS estimates. On the other hand, the estimate obtained using the instrumental variable is liable to suffer from a different problem: whereas the estimate obtained from the instrumental variable regression is in general a consistent estimator of the return to schooling among those who were affected by the policy change, it may not be a consistent estimator for those who were not (i.e., other Oriental Jews). In the case of the Free Education Law and the Compulsory Education Law, it can be claimed that these laws primarily affected liquidity-constrained individuals with a high return to schooling and therefore an overestimate is obtained for the general population. On the other hand, it is reasonable to assume that the probability of dropping out of school among liquidity-constrained individuals (prior to the enactment of the Law) was negatively related to ability and motivation, which thus produces the opposite effect. We would point out that similar effects have been found in other studies that estimated the return to schooling using laws for compulsory education or free education as instrumental variables.[13] There are those who view this result as one of the reasons for the high estimates attained in studies that use instrumental variables in comparison to those that use OLS variables (in addition to measurement error).

5. INSTRUMENTAL VARIABLES—DATE OF BIRTH

Angrist and Krueger (1991) avoided the problem of endogeneity between education and ability in a unique manner by using the fact that in the US the level of education of individuals born at the beginning of the year is lower than for individuals born at the end of the year. In their opinion, the gap in education is the result of the fact that the compulsory education law specifies the age of the pupil rather than years of schooling and therefore allows students who began school at a later age (those born at the beginning of the year) to end their education with one year less of schooling than pupils who were born at the end of the year. The use of the instrumental variable makes it possible to estimate the additional income of those who were forced to spend longer in school due to the Compulsory

[13] This problem does not exist for the instrumental variable used by Angrist and Krueger (1991) which is discussed below.

Education Law (longer than those who were born at the beginning of the year). The use of the instrumental variable makes it possible to overcome the problem of endogeneity between education and other variables if the date of birth is random. This randomness ensures that there will be no systematic gap in motivation or intelligence between individuals born at the beginning of the year and those born at the end of the year and that the earning differential between them will only reflect the difference in their levels of education.

An analysis of the situation in Israel indicates that there is a link between education and date of birth. Thus, the level of education of individuals born in the winter months (October to March inclusive) is lower than that of individuals born in the summer (April to September inclusive) and the difference is statistically significant. The data from the 1995 Census of Population and Housing shows that among individuals born in Israel during the period 1956–73, there was a statistically significant differential of 0.1 years of schooling between individuals born in the summer and those born in the winter. This differential primarily reflects the gap among populations with a low level of education and who would be expected to benefit from the Compulsory Education Law, i.e., Jews whose parents were born in Asia/Africa and Moslems. In contrast, the differentials in education were not statistically significant among relatively educated groups, i.e., Jews whose parents were born in America/Europe, Christians and second-generation Israelis (see Table 8).

Table 8
Average levels of education, income and number of siblings according to season of birth (winter or summer) and ethnic group—native Israelis during the period 1956–73

	Total population		Weak sectors		Strong sectors	
	Born in summer	Born in winter	Born in summer	Born in winter	Born in summer	Born in winter
Education	12.45	12.34	11.82	11.73	13.41	13.37
	(2.58)	(2.59)	(2.51)	(2.52)	(2.37)	(2.35)
Labor income	2,989	3,016	2,800	2,803	3,243	3,331
	(3,148)	(3,210)	(2,783)	(2,701)	(3,564)	(3,820)
Number of siblings	4.73	4.88	5.62	5.75	3.38	3.40
	(2.67)	(2.84)	(2.76)	(2.82)	(1.82)	(1.88)
Observations	147,848		90,833		57,015	
Percent born in winter	50.3		51.3		48.8	

Standard deviations appear in parentheses. The average wage relates to a sub-sample of working individuals who comprise 25 percent of the sample.
Strong sector – Jews with parents born in Israel, Europe or America and Christians.
Weak sector – Moslems and Druse and Jews whose parents were born in Asia or Africa.

Bound and Jaeger (1996) claimed that the season of birth is correlated with the family's socioeconomic background and therefore the use of season of birth as an instrumental variable is not valid. Our investigation of Israeli data supports this claim. It was found that the number of siblings of individuals born in winter is higher than that of individuals born in summer and that the difference was statistically significant. Furthermore, the probability of individuals born in winter to belong to an ethic group with a low level of education

(Moslem, Druse and Jews with parents born in Asia/Africa) is higher than for individuals born in the summer (see Table 8). Thus, the differentials according to season of birth do not only reflect differentials in education but also better environmental conditions that are likely to provide additional advantages (apart from those resulting from education). The correlation between the instrumental variable and socioeconomic background (number of siblings and ethnic group) undermines the validity of the instrumental variable. This is in spite of the fact that the differential in education between those born in summer and those born in winter remains significant even when the effect of ethnic group and number of children is neutralized since there is no way to determine whether or not this differential reflects others unobservable variables.

6. CONCLUSION

The goal of this study has been to isolate the causal link between education and earnings in Israel. The OLS estimate of the return to schooling, which does not take into account characteristics such as intelligence, motivation and perseverance, is likely to be upwardly biased. This is because the labor market compensates these characteristics and because they are correlated with education. Thus, the return to schooling is likely to include a return to ability and motivation.

In order to estimate the causal relation between education and earnings, we used two different methods: The first is to include variables in the regression that are proxies for the individual's unobserved characteristics. It is generally assumed that these characteristics are correlated with observable characteristics of the family, such as mother's level of education, earnings of siblings and siblings' level of education, for which we controlled. The inclusion of these observable characteristics reduced the Mincer estimate of the return to schooling by 1.3–2 percentage points. However, Griliches (1977) showed that such a difference is not evidence of a bias in the Mincer estimation but rather of a measurement error in years of schooling.

The second method to estimate the causal relation between education and earnings is to identify an external event that caused individuals to increase their level of education. The event used in this study occurred in 1979 and included the extension of the Compulsory Education Law to include Grades 10 and 11 under the free education provision and to include Grade 10 under the compulsory education provision. This event led to an increase in the number of years of schooling among the sons and daughters of parents born in Asia and Africa who started high school after the enactment of the Law. A comparison of the earnings of the generation that was affected by the Law to those of the previous generation revealed that the return attained by young Oriental individuals on the additional schooling they acquired was estimated to be 8 percent during the period 1996-2005 (on average) and 12.4 percent (and even higher) in 1995. The return to schooling estimated by a conventional OLS regression for that same group and during that same period is 9.5 percent and is not significantly different from that obtained in the instrumental variable regression's. Thus, the results obtained when using an instrumental variable do not point to the existence of a bias in the estimator of the return to schooling in a conventional regression.

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Table A1
The return to schooling in an intergenerational sample and in a sample of siblings. Dependent variables: log of earnings. Sample: 26-45-year-old natives; 1995 Census data

	Intergenerational sample		Sample of siblings		Sample of siblings and father's earnings		Cross-section of siblings and intergenerational	
	2	3	4	5	6	7	8	9
Years of schooling	0.070 *0.003*	0.062 *0.002*	0.075 *0.002*	0.064 *0.002*	0.071 *0.003*	0.058 *0.003*	0.067 *0.006*	0.050 *0.007*
Father's Income 1988		-9E1.2* -10E1.5*				-9E1.3* -10E2.3*		-9E1.3* -10E2.3*
Father's age		0.0007 (0.0009)						
Father's education		0.007 (0.001)						0.011 (0.005)
Number of siblings		-0.014 (0.003)		-0.019 (0.002)		-0.023 (0.003)		-0.017 (0.007)
Log of sibling's earnings				0.119 (0.009)		0.090 (0.013)		0.133 (0.027)
Sibling's education				0.005 (0.002)		0.007 (0.003)		0.004 (0.007)
Age of sibling				-0.004 (0.001)		-0.004 (0.002)		-0.003 (0.004)
Gender of sibling				-0.081 (0.012)		-0.066 (0.016)		-0.063 (0.033)
Gender	0.38 (0.01)	0.38 (0.01)	0.48 (0.01)	0.48 (0.01)	0.48 (0.02)	0.48 (0.02)	0.41 (0.03)	0.42 (0.03)
Age	0.030 (0.015)	0.038 (0.02)	0.065 (0.02)	0.068 (0.02)	0.077 (0.02)	0.083 (0.02)	0.083 (0.05)	0.081 (0.05)
Age squared	-0.0008 (0.0002)	-0.0002 (0.0002)	-0.0006 (0.0002)	-0.0007 (0.0002)	-0.0007 (0.0003)	-0.0008 (0.0003)	-0.0008 (0.0007)	-0.0007 (0.0006)
Ashkenazi	-0.04 (0.02)	-0.03 (0.02)	0.05 (0.02)	0.03 (0.02)	0.04 (0.03)	0.04 (0.03)	-0.07 (0.05)	-0.07 (0.05)
Oriental	-0.07 (0.01)	-0.01 (0.02)	-0.12 (0.02)	-0.06 (0.02)	-0.12 (0.02)	-0.04 (0.02)	-0.13 (0.04)	-0.05 (0.04)
Non-Jewish	-0.33 (0.02)	-0.20 (0.02)	-0.37 (0.02)	-0.24 (0.02)	-0.31 (0.03)	-0.15 (0.03)	-0.39 (0.07)	-0.22 (0.07)
Log of hours worked	0.15 (0.01)	0.15 (0.01)	0.16 (0.01)	0.16 (0.01)	0.17 (0.01)	0.17 (0.01)	0.19 (0.02)	0.18 (0.01)
Dummy - divorced	-0.14 (0.03)	-0.15 (0.03)	-0.15 (0.03)	-0.15 (0.03)	-0.12 (0.05)	-0.13 (0.04)	-0.17 (0.08)	-0.19 (0.08)
Dummy – widow	-0.19 (0.13)	-0.19 (0.12)	-0.02 (0.09)	0.02 (0.09)	-0.11 (0.13)	-0.09 (0.13)	-0.12 (0.37)	-0.23 (0.35)
Dummy – single	-0.15 (0.01)	-0.15 (0.01)	-0.08 (0.02)	-0.09 (0.02)	-0.06 (0.03)	-0.08 (0.03)	-0.10 (0.03)	-0.11 (0.04)
Dummy – divorced sibling				-0.01 (0.03)				
Dummy – widowed sibling				-0.16 (0.08)				
Dummy – single sibling				0.02 (0.02)				
Constant	5.78 (0.26)	5.68 (0.25)	5.07 (0.27)	4.35 (0.27)	4.84 (0.38)	4.28 (0.39)	4.78 (0.78)	3.94 (0.79)
Observations	12,384	12,384	10,748	10,748	5,692	5,692	1,234	1,234
R^2	0.273	0.282	0.321	0.340	0.320	0.340	0.321	0.361

Table A2
The return to schooling in a sample of siblings – Regression of differences. Dependent variable: Earnings differences. Sample: 26-45-year-old natives 1995 Census data

	1	2
Difference in years of schooling	0.054	0.054
	0.004	*0.004*
Difference in hours worked	0.137	0.137
	(0.011)	(0.011)
Difference in age	0.025	0.025
	(0.002)	(0.002)
Gender sibling 1	0.500	0.500
	(0.021)	(0.021)
Gender sibling 2	-0.501	-0.501
	(0.021)	(0.021)
Sibling 1 divorced		-0.203
		(0.058)
Sibling 1 widowed		-0.080
		(0.191)
Sibling 1 single		-0.122
		(0.038)
Sibling 2 divorced		-0.103
		(0.059)
Sibling 2 widowed		-0.266
		(0.156)
Sibling 2 single		0.087
		(0.035)
Constant	0.013	0.021
	(0.018)	(0.018)
Observations	5,154	5,154
R^2	0.267	0.272

Table A3
Years of schooling and proportion of high school graduates among native Israelis according to year of birth and father's ethnic origin

Year of Birth	All native-born		Asia/Africa		Europe/America		Israel-Jews		Israel-Arabs	
	Years of Schooling	High School Graduates (%)	Years of Schooling	High School Graduates (%)	Years of Schooling	High School Graduates (%)	Years of Schooling	High School Graduates	Years of Schooling	High School Graduates (%)
1955	11.4	62	12.1	67	14.5	91	14.0	88	5.9	15
1956	11.5	65	11.8	68	14.0	86	13.4	85	6.9	24
1957	11.9	69	12.2	75	14.6	93	14.3	92	7.0	23
1958	11.6	67	12.2	73	14.0	89	13.6	85	6.8	23
1959	12.2	70	12.2	75	14.4	92	14.3	87	8.7	30
1960	11.5	66	12.1	73	14.4	91	13.2	82	7.9	30
1961	11.8	67	12.4	75	14.6	93	14.5	91	8.0	29
1962	12.0	70	12.5	79	14.3	91	14.1	87	8.3	30
1963	12.0	72	12.7	83	14.1	88	14.5	92	8.5	35
1964	12.0	71	12.6	81	13.9	90	14.3	91	8.6	31
1965	12.4	76	12.6	85	14.0	91	13.8	87	9.8	43
1966	12.3	75	12.6	83	14.6	91	14.1	89	9.4	43
1967	12.6	76	12.8	85	14.7	91	14.8	95	9.3	40
1968	12.4	76	12.8	85	15.1	96	14.4	93	8.9	38
1969	12.7	79	13.0	87	14.2	92	14.3	90	9.7	45
1970	12.7	78	13.3	89	14.6	94	14.6	92	9.3	41
1971	12.3	74	13.1	86	14.3	88	14.4	90	8.7	40
1972	12.8	79	13.2	90	14.3	89	14.3	90	9.9	45
1973	12.7	77	13.0	82	14.4	93	14.3	88	9.7	47
1974	12.7	78	12.9	84	13.9	85	13.8	88	10.1	51
1975	12.6	77	13.1	85	14.1	87	13.7	85	9.7	49

Source: Census of Population and Housing 1995.

Table A4
The return to schooling estimated by 2SLS— Instrumental variable: Extension of Education Law, First stage regression; Dependent variable: Years of schooling; 1995 Census data

	Model 1		Model 2		Model 3		Model 4	
	Born in 1959–61 and in 1964–66				Born in 1960–61 and in 1964–64			
	Est	STD	Est	STD	Est	STD	Est	STD
Constant	18.949	0.309	18.856	0.378	19.258	0.380	18.894	0.467
Oriental females*Law	0.322	*0.083*	-	-	0.177	*0.103*	-	-
Oriental males*Law	0.487	*0.087*	-	-	0.330	*0.107*	-	-
Father's earnings*Law	-	-	-0.004	*0.001*	-	-	-0.004	*0.002*
Number of siblings*Law	-	-	0.060	*0.014*	-	-	0.049	*0.017*
Father's earnings in 1988	-	-	0.012	*0.001*	-	-	0.012	*0.001*
Number of siblings	-	-	-0.228	*0.012*	-	-	-0.220	*0.015*
Dummy – Ashkenazi females	-0.145	*0.080*	-0.069	*0.092*	-0.240	*0.099*	-0.130	*0.113*
Dummy – Oriental males	-2.107	*0.075*	-1.320	*0.080*	-2.113	*0.093*	-1.412	*0.099*
Dummy – Oriental females	-1.935	*0.081*	-1.100	*0.086*	-1.943	*0.100*	-1.165	*0.106*
Second-generation Israeli males	-0.079	*0.079*	0.121	*0.088*	-0.106	*0.097*	0.094	*0.107*
Second-generation Israeli females	-0.072	*0.087*	0.140	*0.097*	-0.156	*0.107*	0.046	*0.121*
Dummy – Arab males	-3.477	*0.068*	-1.776	*0.112*	-3.569	*0.083*	-1.899	*0.138*
Dummy – Arab females	-1.820	*0.128*	-0.662	*0.181*	-2.085	*0.158*	-1.010	*0.224*
Dummy – single	0.276	*0.052*	0.184	*0.060*	0.199	*0.065*	0.093	*0.075*
Dummy – divorced	-0.493	*0.098*	-0.584	*0.117*	-0.560	*0.126*	-0.662	*0.151*
Dummy – widowed	-0.620	*0.405*	-0.773	*0.492*	-1.127	*0.495*	-0.807	*0.581*
Hours worked	-1.236	*0.077*	-1.111	*0.094*	-1.274	*0.095*	-1.077	*0.117*
Dummy – born in 1959	0.135	*0.069*	0.147	*0.088*	-	-	-	-
Dummy – born in 1960	0.124	*0.068*	0.149	*0.088*	0.007	*0.073*	0.037	*0.095*
Dummy – born in 1961	0.259	*0.068*	0.196	*0.086*	0.144	*0.072*	0.088	*0.093*
Dummy – born in 1964	0.088	*0.057*	0.151	*0.067*	0.047	*0.058*	0.066	*0.068*
Dummy - born in 1965	0.037	*0.057*	0.081	*0.066*	-	-	-	-
R^2	0.1946		0.1947		0.1965		0.1965	
Observations	22,315		13,829		14,822		9,131	

Table A4b
Second-stage 2SLS regressions – Dependent variable: Earnings in 1995

	Model 1		Model 2		Model 3		Model 4	
	Born in 1959-61 and in 1964-66				Born in 1960-61 and in 1964-64			
	Est	STD	Est	STD	Est	STD	Est	STD
Constant	4.075	*0.679*	3.549	*0.764*	3.705	*1.030*	3.172	*1.087*
Years of schooling	0.124	*0.036*	0.145	*0.040*	0.142	*0.067*	0.162	*0.057*
Number of siblings	-	-	-0.001	*0.009*	-	-	0.001	*0.012*
Father's earnings in 1988	-	-	0.000	*0.000*	-	-	0.000	*0.001*
Dummy Ashkenazi females	-0.273	*0.018*	-0.266	*0.020*	-0.254	*0.027*	-0.230	*0.026*
Dummy Oriental males	-0.021	*0.070*	0.045	*0.051*	0.039	*0.137*	0.099	*0.078*
Dummy Oriental females	-0.287	*0.062*	-0.220	*0.044*	-0.233	*0.121*	-0.167	*0.066*
Second-generation Israeli males	0.023	*0.017*	0.032	*0.020*	0.024	*0.022*	0.027	*0.024*
Second-generation Israeli females	-0.255	*0.019*	-0.227	*0.022*	-0.244	*0.026*	-0.209	*0.027*
Dummy – Arab males	-0.189	*0.125*	-0.088	*0.081*	-0.113	*0.242*	-0.034	*0.120*
Dummy – Arab females	-0.516	*0.071*	-0.432	*0.050*	-0.431	*0.145*	-0.369	*0.080*
Dummy – single	-0.147	*0.015*	-0.142	*0.015*	-0.158	*0.019*	-0.160	*0.018*
Dummy – divorced	-0.084	*0.028*	-0.070	*0.035*	-0.093	*0.047*	-0.084	*0.050*
Dummy – widowed	-0.050	*0.090*	-0.120	*0.113*	-0.043	*0.132*	-0.075	*0.138*
Hours worked	0.715	*0.047*	0.765	*0.049*	0.741	*0.088*	0.799	*0.067*
Dummy – born in 1959	0.181	*0.013*	0.202	*0.017*	-	-	-	-
Dummy – born in 1960	0.147	*0.013*	0.155	*0.017*	0.137	*0.015*	0.149	*0.017*
Dummy – born in 1961	0.122	*0.013*	0.133	*0.017*	0.110	*0.013*	0.127	*0.017*
Dummy – born in 1964	0.042	*0.013*	0.048	*0.016*	0.029	*0.013*	0.042	*0.016*
Dummy – born in 1965	0.012	*0.012*	0.004	*0.015*	-	-	-	-
R^2	0.2331		0.2566		0.2268		0.2437	
Observations	22,315		13,829		14,822		9,131	

Table A5
2SLS estimate of return to schooling – Instrumental variable: Free High School Education Law First-stage regression – Dependent variable: Years of schooling Census data 2001-2005

	Model 5		Model 6	
	Born in 1959-61 and in 1964-66		Born in 1960-61 and in 1964-64	
	Estimate	STD	Estimate	STD
Constant	15.29665	0.15811	15.41501	0.12773
Dummy – Arab males	-3.41269	0.10078	-3.53604	0.0782
Dummy – Arab females	-2.06346	0.14776	-2.17574	0.11578
Dummy – Oriental males	-2.38769	0.11369	-2.42709	0.08802
Dummy – Oriental females	-1.74916	0.10936	-1.83825	0.08419
Dummy – males	0.00309	0.09911	-0.05216	0.0747
Hours worked	-0.00692	0.00277	-0.00882	0.00214
Dummy – unmarried	-0.36638	0.11919	-0.3616	0.0909
Dummy – widowed	-0.50129	0.15454	-0.56671	0.11953
Dummy – divorced	-0.05721	0.11467	-0.08918	0.08447
Dummy – Oriental males*Law	0.56421	0.12856	0.5705	0.09999
Dummy – Oriental females*Law	0.3789	0.13354	0.35083	0.10252
Dummy – born in 1957	-	-	-0.22866	0.10047
Dummy – born in 1958	-	-	-0.27827	0.10003
*Dummy – born in 1959	0.01758	0.10557	-0.00719	0.09886
Dummy – born in 1960	0.0389	0.10486	0.0147	0.09818
Dummy – born in 1961	0.00331	0.10592	-0.01786	0.09922
Dummy – born in 1964	-0.13031	0.09045	-0.14982	0.08893
Dummy – born in 1965	-0.11559	0.08908	-0.13046	0.08754
Dummy – born in 1966	-	-	-0.02114	0.08842
Dummy – born in 1967	-	-	-0.0629	0.08717
Dummy – born in 1996	-0.35619	0.13156	-0.36583	0.10163
Dummy – born in 1997	-0.4518	0.13391	-0.33819	0.10344
Dummy – born in 1998	-0.21368	0.11116	-0.16274	0.08503
Dummy – born in 1999	-0.21066	0.11143	-0.1392	0.08572
Dummy – born in 2000	0.06927	0.11458	0.05713	0.08733
Dummy – born in 2002	-0.07793	0.11384	0.0541	0.08747
Dummy – born in 2003	0.24303	0.11385	0.31969	0.08725
Dummy – born in 2004	0.16373	0.11334	0.19555	0.08705
Dummy – born in 2005	0.08786	0.11109	0.17861	0.0865
R^2	0.1561		0.1642	
Observations	11,101		18,457	

Table A5b
Second-stage 2SLS regression – Dependent Variable: Earnings 2001-2005

	Model 5		Model 6	
	Born in 1959–61 and in 1964–66		Born in 1960–61 and in 1964–64	
	Estimate	STD	Estimate	STD
Constant	6.8929	0.62594	6.83218	0.49588
Dummy – Arab males	-0.03913	0.13985	-0.03432	0.11396
Dummy – Arab females	-0.25701	0.08849	-0.24716	0.07315
Dummy – Oriental males	0.16033	0.08649	0.15902	0.06896
Dummy – Oriental females	-0.09945	0.0652	-0.08516	0.05429
Dummy – males	0.32049	0.01866	0.31036	0.01431
Hours worked	0.01757	0.000595	0.01802	0.000494
Dummy – unmarried	-0.14455	0.02693	-0.14364	0.02081
Dummy – widowed	-0.11524	0.03546	-0.1163	0.02899
Dummy – divorced	-0.16589	0.02173	-0.16952	0.01631
Years of schooling	0.08079	0.04056	0.08031	0.03192
Dummy – born in 1957	-	-	0.15624	0.02271
Dummy – born in 1958	-	-	0.14446	0.02355
Dummy – born in 1959	0.09875	0.01938	0.14895	0.01873
Dummy – born in 1960	0.08848	0.01891	0.13823	0.01836
Dummy – born in 1961	0.07599	0.01971	0.1255	0.01893
Dummy – born in 1964	0.02677	0.01779	0.07721	0.0175
Dummy – born in 1965	-0.00734	0.01735	0.04324	0.01707
Dummy – born in 1966	-	-	0.05112	0.01681
Dummy – born in 1967	-	-	0.03434	0.01667
Dummy – born in 1996	-0.36818	0.02867	-0.3768	0.02257
Dummy – born in 1997	-0.26604	0.0312	-0.27457	0.02248
Dummy – born in 1998	-0.15988	0.02272	-0.15323	0.01701
Dummy – born in 1999	-0.09834	0.02275	-0.09047	0.01695
Dummy – born in 2000	0.04746	0.0217	0.03033	0.01667
Dummy – born in 2002	0.08281	0.02169	0.06785	0.0167
Dummy – born in 2003	0.05416	0.02354	0.04732	0.01943
Dummy – born in 2004	0.09227	0.02226	0.0904	0.0176
Dummy – born in 2005	0.10698	0.02116	0.09644	0.01732
R^2	0.3395		0.3364	
Observations	11,101		18,457	

Table A6
Estimation of the return to schooling among 26-45-year-old natives 1995 Census data

Regression 1 – Return to the highest diploma achieved			Regression 2 – Return to a year of schooling according to age, gender and ethnic group		
	Coefficient	DTD		Coefficient	STD
Constant			Constant	7.758	*0.407*
			Year of schooling	-0.139	*0.031*
Gender	0.5181	*0.0045*	Gender	0.674	*0.021*
Age	0.0690	*0.0049*	Age	-0.063	*0.023*
Age squared	-0.0007	*0.0001*	Age squared	0.001	*0.000*
Hours worked	0.1499	*0.0032*	Hours worked	0.152	*0.003*
Ashkenazi	0.0105	*0.0070*	Ashkenazi	0.048	*0.037*
Oriental	-0.0847	*0.0066*	Oriental	-0.408	*0.035*
Non-Jew	-0.3734	*0.0079*	Non-Jew	-0.451	*0.036*
No diploma	-0.38532	*0.01122*	Years of schooling* gender	-0.013	*0.002*
elementary school	-0.34883	*0.00761*	Years of schooling* age	0.010	*0.002*
High school graduate	-0.15138	*0.0065*	Years of schooling*age^2	-0.00012	*0.00002*
Post-high school	0.10492	*0.00698*	Years of schooling* Oriental	0.023	*0.002*
First degree	0.29378	*0.00711*	Years of schooling*Ashkenazi	-0.003	*0.003*
Second degree	0.3665	*0.01128*	Years of schooling*non-Jew	0.004	*0.003*
Third degree	0.34349	*0.02068*			
R^2	0.3517		R^2	0.3400	
Observations	70,534		Observations	71,586	